T. PULLAIAH* & D. NARAHARA*: Embryology of *Filago arvensis* L. (Asteraceae)

T. プライア*・D. ナラハラ*: *Filago arvensis* L. (キク科) の胚学的研究

The genus *Filago* (tribe Inuleae, family Asteraceae) comprises 20 species. Not even a single species of this genus has been investigated embryologically. The embryology of *Filago arvensis* is reported here.

Material and methods Capitula of *Filago arvensis* L., at different stages of development, were collected from Nilgiris and fixed in formalin acetic alcohol (F.A.A.). After processing in Tertiary butyl alcohol series, the material was embedded in paraffin wax (58–60°C). Serial longitudinal and transverse sections were cut at 3–6 μm and stained in Delafield's haematoxylin. Voucher specimen no. TP 3093 has been deposited in the Herbarium of Sri Krishnadevaraya University.

Observations Microsporangium, microsporogenesis and male gametophyte. Anthers are tetrasporangiate. The male archesporium is hypodermal and consists of a single row of 5–7 cells (Fig. 1A). The archesporial cells are large and have dense cytoplasm and prominent nuclei. The cells of the archesporium undergo periclinal divisions forming primary parietal layer and primary sporogenous layer. The primary parietal layer undergoes periclinal division forming two layers (Fig. 1B), of these the inner forms the tapetum while the outer divides periclinally forming a middle layer and endothecium (Fig. 1C). Thus, the development of anther wall is of the Dicotyledonous type.

The flattened remnants of epidermal cells persist in mature anther. The endothecium develops fibrous thickenings. Anther tapetum is of the Periplasmodial type. Its cells become two-nucleate. At 1-nucleate stage of pollen grains, when pollen wall has already differentiated, the walls of the tapetal cells break down and the cytoplasm of the tapetal cells coalasce forming periplasmodium (Fig. 1D). The tapetum is consumed by the developing pollen grains and no trace of it is left at maturity.

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The primary sporogenous cells undergo only transverse divisions resulting in a single row of cells (Fig. 1C). The pollen mother cells undergo meiosis and the tetrads are tetrahedral (Fig. 1E). Quadripartition of microspores takes place by furrowing. The microspores, soon after release from the tetrad, enlarge and develop a thick exine and thin intine. Later the nucleus is pushed to a side, while the centre has a large vacuole (Fig. 1F). The mature pollen

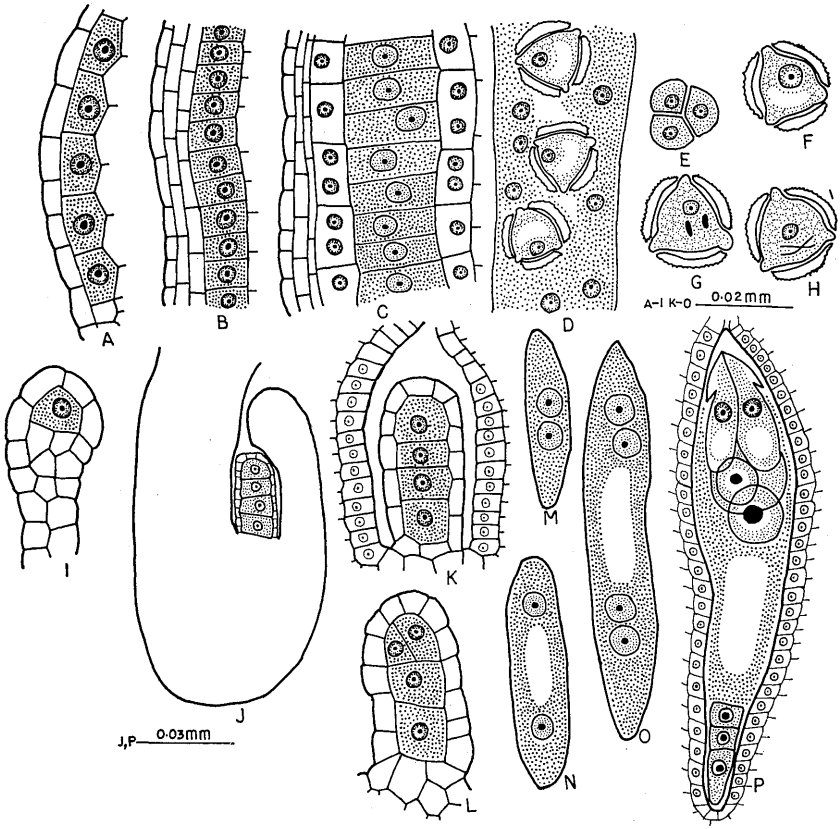

Fig. 1. *Filago arvensis*. *A*. Longitudinal section of part of anther lobe showing archesporial cells. B. Parietal layers and sporogenous cells. C. Wall layers and pollen mother cells. D. Periplasmodium and 1-nucleate pollen grains. E. Tetrahedral pollen tetrad. F. One-nucleate pollen grain. G, H. Mature 3-celled pollen grains. I. Ovule with archesporial cell. J. Anatropous condition. K, L. Linear and T-shaped tetrads. M-P. Developmental stages of embryo sac.

grain is 3-celled with three germ pores (Fig. 1G, H). The sperm cells are at first oval-shaped (Fig. 1G) but finally become filiform (Fig. 1H).

Ovary and ovule. The ovary is bicarpellary, syncarpous and unilocular with a single basal ovule. The ovule arises as a papillate outgrowth from the placenta at the base (Fig. 1I). Due to anticlinal and periclinal divisions only on one side, the ovule turns at right angles to the funiculus. Due to continued curvature the ovule becomes anatropous (Fig. 1J). The ovule is unitegmic and tenuinucellate. The integument towards the funicle fuses with the funicle and its identity is lost (Fig. 1J). At about the megaspore tetrad formation the cells of inner integument enlarge rapidly, acquire dense cytoplasm and function as integumentary tapetum (Fig. 1K). It remains uniseriate with uninucleate cells (Figs. 1P, 2A, C). It gradually collapses with the development of the embryo.

The female archesporium is hypodermal and single-celled (Fig. 1I). It functions directly as megaspore mother cell, undergoes meiotic division resulting in linear (Fig. 1K) and occasionally T-shaped tetrads (Fig. 1L). The three micropylar megaspores degenerate, while the chalazal enlarges considerably and its nucleus undergoes a division forming two nuclei (Fig. 1M). With the continued enlargement of the embryo sac the nuclei move to the poles (Fig. 1N). These two nuclei undergo two mitotic divisions resulting in 8 nuclei. At the micropylar pole three nuclei organise into egg apparatus, two nuclei fuse near the egg apparatus and three nuclei at the chalazel end form antipodal cells (Figs. 1P, 2C).

Fertilisation, endosperm and embryo. The entry of pollen tube is porogamous (Fig. 2A). Fertilisation is normal and syngamy is completed earlier than triple fusion (Fig. 2A).

The primary endosperm nucleus divides earlier than the zygote (Fig. 2B). The endosperm development is of the Nuclear type (Fig. 2B, C). Wall formation is initiated at about the 8-celled proembryo stage. The endosperm cells undergo further divisions resulting in a massive tissue. Except for one or two layers the endosperm is completely absorbed by the growing embryo.

The zygote undergoes a transverse division resulting in a terminal cell *ca* and a basal cell *cb* (Fig. 2D, E). Both the cells undergo another division, the terminal cell vertically and the basal cell transversely (Fig. 2G). The derivatives of *ca* are designated as *m* and *ci*. Sometimes the basal cell divides earlier than the terminal cell forming a 3-celled proembryo (The 2F). The two cells of the tier

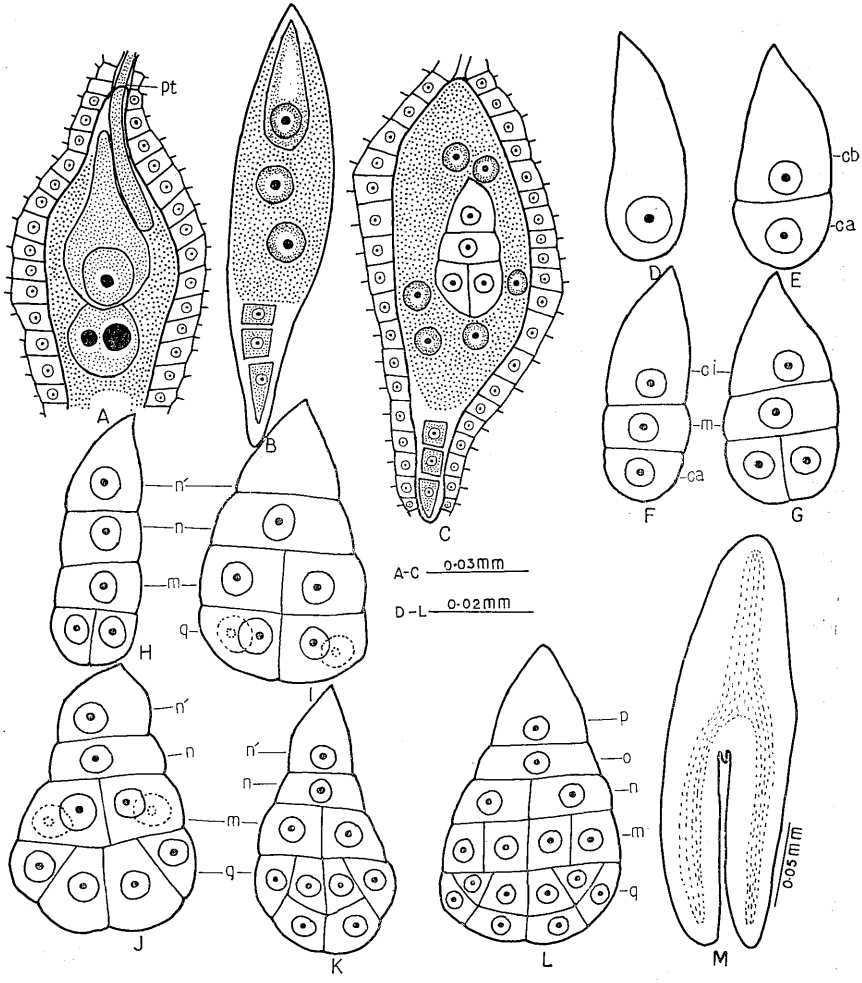

Fig. 2. *Filago arvensis*. A. Embryo sac with zygote and triple fusion. B. C. Stages in the development of endosperm. D. Zygote. E-M. Stages in the development of embryo.

ca undergo another vertical division, at right angles to the previous one, forming the quadrants *q* (Fig. 2I). Meanwhile, *ci* undergoes transverse division giving rise to *n* and *n'* (Fig. 2H, I). Later, *n'* divides transversely forming the tiers *o* and *p* (Fig. 2L).

During further growth (Fig. 2G-M) the tier *q* contributes to stem tip and cotyledons, *m* to hypocotyl and plerome initials of root, *n* and *o* to root tip and root cap. The tier *p* undergoes further divisions forming 3 to 4-celled suspensor. The mature embryo is straight (Fig. 2M). Thus the development conforms to the Asterad type—senecio variation. According to the Souèges system (Crètè, 1963) Megarchetype II, series A, subseries A_2 in the first embryonic group.

Discussion In the tribe Inuleae the anther is usually tetraspsrangiate, but bisporangiate condition has been reported in *Blumea membranacea* (Pullaiah 1979). The development of embryo sac is of the Polygonum type (see also Pullaiah 1984). However, in *Ammobium alatum* the development is of the Allium type (Avanzi 1948, Davis 1962); in *Helichrysum bracteatum* of the Drusa type (Tongiorgi 1942) and *Leontodon hispidus* both Polygonum and Adoxa types occur (Bergman 1935).

Both Nuclear and Cellular types of endosperm are known. Cellular type is known in *Gnaphalium undulatum* (Dahlgren 1929), *Blumea laciniata* (Banerji 1942), *Podolepis jacecides* and other species of this genus (Davis 1961), *Caesulia axillaris* (Deshpande 1962), *Ammobium alatum* (Davis 1962), *Leontodon alpinum* (Maugini 1962), *Epaltes australis* (Davis 1968) and *Blumea membranacea* (Pullaiah 1979). Nuclear type occurs in *Blumea oxydonta, B. eriantha* (Chennaveeraiah and Patil 1971), *Antennaria alpina, A. porsildii* (see Davis 1966), *Blumea malabarica* (Pullaiah 1979) and *Filago arvensis* (present study).

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Filago arvensis L. の花粉形成，大胞子，胚嚢形成，胚乳形成，胚形成を調べた。葯室の壁の出来方は Dicotyledonous type である。タペタムは Periplasmoidal type である。花粉は3細胞期に放出される。4個の大胞子は1列またはT型に並ぶ。胚嚢形成は Polygonum type で，反足細胞は3細胞が1列に並び，胚乳形成の際にも多細胞にならない。胚乳形成は多核型である。胚形成は Asterad type である。

□小水内長太郎： **遠野市植物誌** 595 pp. 1987. 遠野市立博物館，岩手県．¥5,000（送料共）．編集は遠野市植物誌編集委員会としてあるが，509頁を占める植物関係の執筆は小水内氏の手に成り，同氏積年の研究の総まとめというべきものである。植物目録は約300頁で，産地が列記されている。他に遠野市植物調査史と明治以前本邦自然史追跡という項目にそれぞれ約50頁が当てられ，著者の蘊蓄が披瀝されている。標本の採集日時のデータがほしかったこと，地名のリストがあれば便利だったろうなどと欲張ったことを考えた。標本が利用できるように保存されることを切望する。（金井弘夫）

□Inoue, H. (ed.): **Studies on cryptogams in southern Peru** 192 pp. 1987. 東海大学出版会，東京．¥9,500. 国立科学博物館がおこなっている「南米における隠花植物の分化と分布に関する研究」（文部省海外学術調査：代表 井上 浩）の第二次調査が1684年にペルー南部でおこなわれたが，これはその成果の一部を取りまとめたもの。10篇の論文が掲載されている。蘚類ギボウシゴケ科の研究，苔類の油体，化学成分等に関する研究（4篇），地衣類カラタチゴケ属の研究，菌類の糞生菌，松葉分解菌などの研究（3篇）と，調査地域の植生に関する概要である。（神田啓史）